The American Journal of Surgery 220 (2020) 10–18

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Performance advantages for grit and optimism

Tyler J. Loftus [a], Amanda C. Filiberto [a], Martin D. Rosenthal [a], George J. Arnaoutakis [a], George A. Sarosi Jr. [a], Justin B. Dimick [b, c], Gilbert R. Upchurch Jr. [a, *]

[a] Department of Surgery, University of Florida Health, Gainesville, FL, USA
[b] Department of Surgery, Michigan Medicine, University of Michigan, Ann Arbor, MI, USA
[c] Center for Healthcare Outcomes and Policy, University of Michigan, Ann Arbor, MI, USA

ARTICLE INFO

Article history:
Received 27 December 2019
Received in revised form
21 January 2020
Accepted 26 January 2020

Keywords:
Grit
Optimism
Resilience
Surgery
Performance
Burnout

ABSTRACT

Background: Unsustainable surgeon burnout rates and moral imperatives for performance improvement suggest an urgent need to understand and apply rationales and methods for cultivating grit and optimism in surgery.
Data sources: Embase, MEDLINE, and PubMed articles.
Conclusions: Passivity in response to negative events is the default human response, but the presence of control activates the prefrontal cortex—the brain region controlling executive function—promoting effort toward solutions. Challenges, failures, and traumatic events perceived as inescapable, permanent, pervasive, and irreparable lead to debility and attrition; grit and optimism shift the human response toward growth, strength, and improved performance. Methods for realizing these advantages include maintaining positivity, pursuing major challenges that match personal skills, engaging in deliberate practice to improve skills, persisting in hard work, and pursuing higher meaning and purpose in work and life. Grit and optimism are difficult to teach; selecting gritty, optimistic surgical residency applicants may also be effective.

Introduction

Epidemic burnout among surgeons has prompted vigorous investigation of burnout epidemiology, etiologies, and solutions.[1,2] Within a one-year period ending July 1st, 2019, there were 229 articles within Embase, MEDLINE, and PubMed regarding surgery and burnout. Five years ago, there were only 40 articles meeting these criteria. Ten years ago, there were 13. Twenty years ago, there were two. This ever-expanding body of literature reflects the serious impact of burnout on quality of care and workforce shortages.[1,3,4] Structural and organizational changes to workforces, call schedules, duty hours, and compensation plans have been proposed and implemented, though evidence for their efficacy is sparse.[2,5–8] A recent *New York Times* Opinion describes the unsustainable pattern of healthcare systems asking ever more of employees, counting on their professional ethic and compassion for patients to supersede self-preservation.[9] Fixing healthcare systems that tolerate or promote surgeon burnout is critically important, but does not address the similarly important role of personal characteristics.[7,8] Some contend that surgeons can prevent and treat burnout by fostering gratitude, compassion, service, and joy in surgery.[10,11] Evidence and expert opinion support this approach, but it may be incomplete.[12–16]

Deeper understanding of depression and post-traumatic stress reveals that promoting their positive counterparts, well-being and post-traumatic growth, may be more effective than prevention and treatment of the diseases themselves.[12,13,17] Similarly, cultivating grit (defined by Paul Stoltz with an acronym: growth, resilience, intensity, and tenacity) and optimism to improve performance may be more effective than prevention and treatment of burnout.[18,19] Shifting the focus from burnout to performance improvement also satisfies moral and professional imperatives to serve and care for patients above all else, secondarily engaging in self-care to maintain physical and psychological fitness to serve and care for patients.

Rationales and methods for cultivating grit and optimism to improve performance are well described in behavioral psychology, neurobiology, and human performance in many endeavors and vocations, but not in surgery. It also remains unclear whether

* Corresponding author. University of Florida Department of Surgery, PO Box 100286, 1600 SW Archer Road, Room 6174, Gainesville, FL, 32610-0286, USA.
E-mail address: gib.upchurch@surgery.ufl.edu (G.R. Upchurch).

https://doi.org/10.1016/j.amjsurg.2020.01.057
0002-9610/

teaching and learning grit and optimism would be effective in surgery. If not, it may be more effective to select gritty, optimistic surgical residency applicants. In either case, unsustainable surgeon burnout rates and professional and moral imperatives for surgical performance improvement suggest that there is an urgent need to understand and apply these principles—illustrated in Fig. 1—in surgical training and practice.

2. Methods

To achieve the former objective, this review assimilates and summarizes findings from relevant Embase, MEDLINE, and PubMed articles. Search methods and included studies are listed in Fig. 2 and Table 1, respectively. Due to the indistinct nature of the topic and heterogeneity of scientific methods in available literature, the authors performed a narrative review with subjective appraisal of included studies.

Results

The perception of control promotes effort toward solutions

Learned helplessness is a behavioral-psychological mode characterized by the perception that negative events are uncontrollable.[20] Someone with learned helplessness may not strive toward a goal because their actions seem meaningless.[17,21] Seligman and Maier first described learned helplessness in 1967, initially studying dogs subjected to electric shocks.[20] One group could turn off the shock by pressing a panel with their noses (i.e. escapable shock). A second group was yoked to the first group—receiving the same number and duration of shocks—but shocks were unaffected by pressing the panel (i.e. inescapable shock). A third group received no shocks. The next day, the same dogs received shocks that were escapable by jumping a barrier between chambers. Ninety percent of the dogs who had escapable shocks or no shocks the previous day jumped the barrier; only one third of the dogs who had inescapable shocks the previous day jumped the barrier. Dogs experiencing inescapable shocks seemed to learn that their actions were meaningless.

Seligman then performed similar experiments on college students.[21] Shocks were replaced with loud, unpleasant noises through headphones during cognitive tasks. Noises could be deterred on one day by pressing a button and on the next day by moving a knob. Results mirrored the animal experiments. Subsequent human experiments revealed that inescapability alone did not produce long-term learned helplessness.[17] When helplessness was perceived as permanent or pervasive, subjects demonstrated helplessness facing new problems in the future; when helplessness was perceived as transient and unique to a specific problem, subjects are less likely to demonstrate helplessness facing new problems in the future.

Original theories held that animals and humans learn that avoiding negative events is futile. Subsequent neurobiological investigations overturned these theories. Instead, passivity in response to negative events is a default, unlearned response. The presence of control activates the prefrontal cortex—the part of the brain that controls executive function—aborting default passivity, and promoting effort toward solutions.[17] This has immense implications for human performance, which often depends on persistence despite challenges and failures.

The human response to challenge and failure is heterogonous

Friedrich Nietzsche wrote, “what does not kill me makes me stronger”.[22] Later, he used a similar phrase to describe someone who turns negative events into advantages.[23] This is true in some cases—e.g. bacteria not destroyed by an antibiotic can mutate toward multi-drug resistance, the early loss of a parent is common among US presidents, British prime ministers, and eminent scientists and poets—but not all cases.[24–26] During World War II, British authorities anticipated that German aerial bombings would crush Londoners’ morale and propagate widespread panic requiring increased access to psychiatric facilities.[27] Instead, Londoners demonstrated stoic indifference and the psychiatric facilities, largely unused, were converted to field hospitals. This may be partially attributable to British cultural values of fortitude and courage under fire, but similar responses to aerial bombings were observed in other countries around the world.[27] Differences

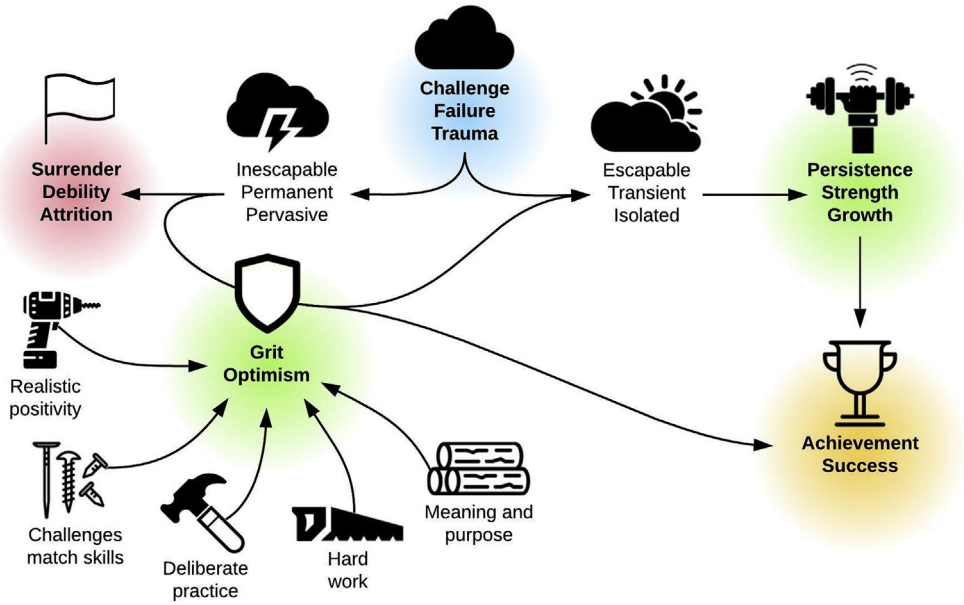

Fig. 1. Grit and optimism shift the human response to challenge and failure toward growth and success.

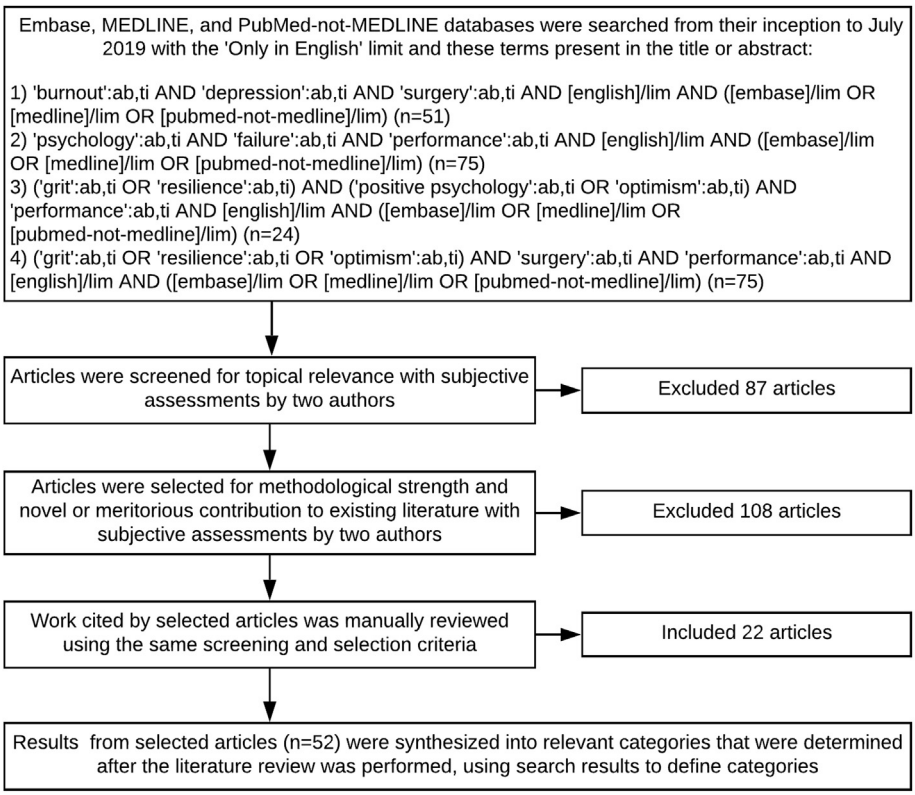

Fig. 2. Article search methods.

between bombing direct hits, near misses, and remote misses may provide a better explanation. MacCurdy observes that direct hits are fatal, and therefore do not affect the long-term morale of the community, which depends on survivors.[28] Some survivors experience near misses, incurring injury and witnessing immediate destruction of their surroundings. Other survivors experience remote misses, hearing a bomb strike a distant location. Near misses are often debilitating; remote misses tend to impart a seemingly paradoxical sense of invulnerability. Aerial bombings of London inflicted approximately 40,000 deaths and 46,000 injuries among a metropolitan area containing over 8 million people. One might expect a population of remote misses to exhibit the kind of courageous stoicism observed among Londoners during World War II aerial bombings.

In surgery, losing a patient in the operating room without technical and social support from colleagues could represent a near miss-type challenge, yielding stress, debility, and burnout. Yet, even traumatizing challenges present opportunities for growth. Peterson et al.[12] measured character strengths among 1739 adults in a validated survey, and then asked respondents to enumerate traumatic events, which were most commonly described as life-threatening accidents, sexual assaults, and physical assaults. As the number of traumatic events increased, there was a linear increase in the strength of several characteristics, including honesty, bravery, leadership, perseverance, creativity, and zest.

Academic failure can promote growth and long-term success for some, and debility and attrition for others. Wang et al.[29] analyzed the citation records of researchers during the first ten years after submitting their first NIH R01 grant application. Within five years, researchers who narrowly missed funding were more likely to publish hit papers—papers in the top 5% of citations received—than funded applicants (16% vs. 13%, $p < 0.001$). Narrowly missing funding was associated with a 61% increase in the likelihood of publishing a hit paper within 10 years and a 34% increase in the average number of citations per paper. Yet, within 10 years of grant submission, applicants who narrowly missed funding were 13% more likely to disappear from the NIH system.

Before the human response to challenge and failure can take place, there must be an opportunity for winning and losing. People often avoid these opportunities. The Nobel Prize-winning psychologists Daniel Kahneman and Amos Tversky found that aversion to loss is approximately twice as strong as satisfaction from gain.[30] Therefore, people tend to avoid situations in which they are likely to fail. Avoidance behavior degrades ambitious goal setting and prevents achievement.[31,32] Fear of failure may portend greater willingness to settle for occupations perceived as being less prestigious and less personally satisfying.[33] Ambitious goal setting seems to be a better approach. The eminent psychologist David McClelland proposed that optimal goals have a 50–70% chance of success.[34]

Grit and optimism shape the human response to challenge and failure

In the learned helplessness experiments described above, approximately one third of the dogs and humans suffering inescapable shock or noise never became helpless. Seligman, who had previously focused on post-traumatic stress and depression, became interested in understanding what made these dogs and humans different. Further research demonstrated that the human response to challenge and failure is normally distributed.[13] One end of the spectrum is characterized debilitating post-traumatic stress, depression, burnout, and predilection for suicide. The middle features temporary stress and depression that abates within months. The other end is characterized by temporary stress and depression that lead to growth and newfound strength. When Nietzsche said,

Table 1
Summary of included studies.

Primary Author	Study Design	Population	Sample Size	Major Findings Pertinent to this Scoping Review	Sources of Funding, Conflicts of Interest
Abelson[43]	Prospective observational	Categorical general surgery interns	828	Interns who expected to work as an attending more than 80 h per week, have a stressful life, and to be the subject of malpractice litigation were less likely to attrite (odds ratio 0.90)	Robert Wood Johnson Foundation
Begg[67]	Retrospective	Prostatectomy patients	11,522	Higher surgeon volume was associated with decreased postoperative morbidity and late urinary complications; there was wide variability in outcomes among high-volume surgeons	None reported
Berntson[61]	Review	–	–	Discusses evidence that concomitant sympathetic and parasympathetic activation provides precise autonomic control of organ function	Sigma Xi scientific research honor society
Birkmeyer[71]	Observational	Bariatric surgeons	20	Surgeons in the top quartile of technical skill per peer evaluations had lower complication and mortality rates than bottom quartile surgeons	Blue Cross Blue Shield of Michigan and Blue Care Network
Brown[51]	Review	–	–	Previous reports of an exact minimum positivity ratio (2.9013) is supported by a nonlinear dynamics model exaggerated the precision and strength of the mathematical foundation for this claim	None reported
Buehlman[55]	Observational	Married couples	52	Observer impressions of positivity and the nature of interactions between couples predicted divorce with 94% accuracy	None reported
Burnstein[33]	Observational	Undergraduate students	67	Fear of failure was associated with greater willingness to settle for occupations perceived as being less prestigious and personally satisfying	Michigan State University School of Labor and Industrial Relations
Campbell[7]	Cross-sectional	Practicing surgeons	582	32% reported high levels of emotional exhaustion; younger age correlated with burnout ($r = -0.28$)	None reported
Cohen[16]	Prospective observational	Healthy volunteers inoculated with rhinovirus	334	Controlling for pre-inoculation antibody levels, there was a dose-response relationship between levels of happiness and objective signs and symptoms of developing a cold	NIMH, John D. and Catherine T. MacArthur Foundation
Cortez[41]	Observational	Medical students on surgery clerkships	62	Students who received Honors grades had higher grit survey scores than peers receiving lower grades	None reported
Cowan[69]	Retrospective	Carotid endarterectomy patients	35,821	Stroke and mortality were lowest for high-volume surgeons; surgeon specialty was not associated with significant differences in stroke or mortality rates	None reported
Danner[15]	Observational	Catholic nuns	180	Positive emotional content in diary writings of young (mean age 22 years) nuns was inverse to long-term mortality (−1.4% decreased mortality per single percentile change in the ranking of number of positive sentences, $p < 0.001$)	NIA, Kleberg Foundation
de Manzano[60]	Observational	Professional pianists	21	Flow states were associated with deeper breaths, decreased heart rate variability, higher diastolic blood pressure, and zygomaticus major facial muscle activation	SRC, Sällskapet barnavård, Söderbergs stiftelser, Freemasons, Stockholm Brain Institute
Diener[48]	Observational	Undergraduate students	23,407	Self-reported positive mood at the time of college entry was associated with higher job satisfaction and income 19 years later	Andrew W. Mellon Foundation
Duckworth[72]	Observational	Eighth-grade students	140	Self-discipline was predictive of grades, attendance, standardized achievement-test scores, and selection into a competitive high school program	NSF, NIMH
Elstein[66]	Review	–	–	Review evidence that advanced clinical reasoning and cognition are necessary to diagnose rare and complex disease, but not common diseases	National Library of Medicine
Ericsson[63]	Review	–	–	Describes how deliberate practice with immediate and formative feedback, problem-solving, and repeated performance with refinement can lead to expert performance	None reported
Ericsson[64]	Review	–	–	Reviews applications of deliberate practice and expert performance theory to medical diagnostics and surgical performance	FSCW/Conradi Endowment Fund
Farina[38]	Prospective observational	US Army Special Forces candidates	800	Grit and resilience were each associated with greater likelihood of selection for US Army Special Forces (Green Berets)	US Army Medical Research and Development Command
FirthCozens[4]	Cross-sectional	Practicing physicians	225	36% of surveyed physicians reported recent incidents that were attributable to personal stress and negatively affected patient car	None reported
Fredrickson[49]	Review	–	–	Describes the theory that positive emotions encourage creativity, exploration, collaboration, and long-term vision, building social, and psychological, and intellectual capital	NIMH, Rackham Faculty Grant, John Templeton Foundation
Fredrickson[50]	Observational	Undergraduate students	104	Positive emotions were associated with broadened attention and thought-action repertoires during visual processing tasks	NIMH, Rackham Faculty Grant, John Templeton Foundation, APA
Fredrickson[54]	Observational	University students	188	University students with better mental health had higher daily ratios of positive to negative emotions (3.2 vs. 2.3)	NIMH, John Templeton Foundation
Gillham[35]	Randomized controlled trial	Middle school children	697	In two of three middle schools, psychological interventions represented in the Penn Resilience Program significantly reduced depressive symptoms	NIMH
Griffith[37]	Cross-sectional	US Army Master Resilience Training participants	611	≥92% reported improved resilience competencies (primarily self-awareness and strength of character); resilience was associated with fewer behavioral health symptoms	None reported
Gustafsson[31]	Cross-sectional	Elite athletes age 15-19	255	Validated survey responses demonstrated that higher levels of fear of failure were associated with higher levels of burnout	None reported
Hashimoto[70]	Randomized controlled trial	Surgery residents	14	Deliberate practice lead to improved performance on virtual laparoscopic cholecystectomy compared with control training (TED talk or journal article)	NCRR, NCATS

(*continued on next page*)

Table 1 (*continued*)

Primary Author	Study Design	Population	Sample Size	Major Findings Pertinent to this Scoping Review	Sources of Funding, Conflicts of Interest
Hill[39]	Review	–	–	Perseverance and resiliency are associated with improved performance on neuropsychological tasks	***
Hiroto[21]	Randomized controlled trial	Undergraduate students	96	Students who experienced escapable unpleasant noises learned to escape from future unpleasant noises; students who experienced inescapable unpleasant noises became helpless	NIMH
Hutter[6]	Prospective observational	Surgery attendings and residents	116	Resident burnout scores decreased after 80-h workweek restrictions were implemented	CRICO/Risk Management Foundation
Jackson[58]	Observational	Elite athletes	28	Qualitative assessment of athletes' experiences suggested that concepts like total concentration and merging of action and awareness occur among elite athletes	None reported
Lebares[19]	Cross-sectional	Surgery residents	566	The prevalence of burnout was 69%, dispositional mindfulness was associated with lower odds of burnout (OR 0.24, $p < 0.0001$)	None reported
Losada[53]	Observational	Business teams	60	A meta learning model demonstrated that positivity was associated with higher performance	None reported
Lyubomirsky[46]	Systematic review, meta-analysis	Articles about psychology and success	225	Across a diverse set of people and tasks, happiness and positive affect was associated with success, and often preceded success	Positive Psychology Network
Murr[32]	Systematic review	Articles about predictors of youth soccer performance	24	Among elite youth soccer players, fear of failure predicted lower performance levels, with lasting effects	Deutsche Forschungsgemeinschaft, University of Tübingen
Peterson[12]	Retrospective	Anonymous web survey respondents	1739	56% had experienced a traumatic life event, as the number of traumatic events increased, there was a linear increase in the strength of several character strength scores	None reported
Pulcrano[2]	Systematic review	Articles about burnoutin surgery	41	Working longer hours and being a resident and were associated with burnout and lower quality of life	None reported
Reivich[36]	Review	–	–	The US Army Master Resilience Training program trains military leaders to optimize their resilience and train others to do the same	Salary support from the US Army
Rikers[65]	Observational	Cardiologists and Neurologists	20	Experts with specialty domain knowledge have higher diagnostic accuracy than peers with similar duration of training but different specialty domain knowledge	None reported
Salles[42]	Observational	Surgery residents	73	Higher grit survey scores were inversely correlated with attrition ($r = -0.37$, $p < 0.01$)	None reported
Schrag[68]	Retrospective	Rectal cancer resection patients	2815	Higher surgeon volume was associated with lower 2-year mortality when adjusting for hospital volume	None reported
Seligman[14]	Randomized controlled trial	Anonymous web survey respondents	577	Three psychological interventions represented in the Penn Resilience Program significantly increased happiness and decreased symptoms of depression	Annenberg/Sunnylands Trust, Atlantic Philanthropies, John Marks Templeton Foundation, NIMH
Seligman[20]	Experimental	Dogs	27	Dogs who experienced escapable shocks learned to escape from future shocks; dogs who experienced inescapable shocks became helpless	NSF, NIMH
Shanafelt[1]	Observational	Members of the ACS	7905	Screen-positive rates of burnout and depression were 40% and 30%; only 51% recommended medicine/surgery as a career for their children	None reported
Staw[47]	Observational	Hospital and automobile manufacturing employees	272	Positive emotions elicited from interviews and direct on-the-job observations were associated with better supervisor evaluations and higher pay over the following 18–20 months	None reported
Tversky[30]	Observational	Undergraduate students	25	In computerized decision-making scenarios, aversion to loss was approximately twice as strong as pursuit of a win, with particular aversion to losses of moderate and low probability	Air Force Office of Scientific Research, NSF, Alfred P. Sloan Foundation
Wang[29]	Retrospective	NIH R01 applicants	1359	Applicants who narrowly missed funding had 61% greater likelihood of publishing a hit paper (top 5% of citations received) in the next ten years vs. applicants who were funded	Air Force Office of Scientific Research, NSF, Alfred P. Sloan Foundation
West[3]	Prospective observational	Internal Medicine residents	184	Burnout was associated with increased odds of self-perceived/self-reported medical errors	Medicine Innovation Development and Advancement System
West[5]	Systematic review, meta-analysis	RCTs about interventions for physician burnout	15	Several structural and organizational interventions decreased physician burnout, but incidence remained high after interventions (before: 54%, after: 44%)	Arnold P. Gold Foundation Research Institute
Williford[8]	Cross-sectional	Surgery attendings and residents	147	Incidence of burnout among residents was 75%; major barriers to seeking care included inability to take time off for treatment and stigma	None reported
Wrzesniewski[74]	Cross-sectional	Employees of a health service or liberal arts college	196	Employees who saw their work as a calling—rather than a job that pays bills or a career that builds social status and prestige—were more satisfied with their work and life	John D. and Catherine T. MacArthur Foundation Network on Health-Related Behaviors
Wrzesniewski[76]	Observational	West Point cadets	11,320	Internal motivations (e.g. desire to serve as an Army officer, being a soldier) were associated with greater likelihood of graduating from West Point and winning promotion during the mandatory 5-year period of military service	Yale School of Management

ACS: American College of Surgeons, RCT: randomized controlled trial, NIH: National Institute of Health, OR: odds ratio, NIMH: National Institute of Mental Health, NIA: National Institute on Aging, NSF: National Science Foundation, APA: American Psychological Association, SRC: Swedish Research Council, NCRR: National Center for Research Resources, NCATS: National Center for Advancing Translational Sciences.

"that which does not kill him makes him stronger," he was probably referring to people on this end of the spectrum. To understand what set them apart, Seligman and his team studied speech and writing among people facing failure.[13] They found that people who consider failures temporary, local, and changeable were less likely to demonstrate attrition. A positive, optimistic mindset was the key to resilience, or the ability to recover from a challenge or failure. Resilience is an essential component of grit, along with growth, intensity, and tenacity. The positive psychology movement was born from the finding that optimism begets resilience.

Seligman and his colleagues hypothesized that optimism could immunize against learned helplessness.[13] They developed the Penn Resilience Program, built on positive emotion, engagement, relationships, meaning, and achievement. Several components increase happiness and decrease depression, with lasting effects.[14,35] This program was adapted to create a Master Resilience Training program for the US Army, in which drill sergeants and other military leaders learn to optimize their resilience and train others to do the same.[13,36] The program builds mental toughness, signature strengths, and strong relationships. In a survey of program participants, 92% or more reported improve resilience competencies, primarily manifest as self-awareness and strength of character. These adaptations were associated with fewer behavioral health symptoms, especially among respondents who had recently experienced stressful events.[37] Therefore, it seems plausible that grit and optimism can be developed, improving psychological strength and fitness. Importantly, they are also associated with improved performance.

Grit and optimism yield performance advantages

Grit yields high performance.[38–40] This is manifest in surgical training. Higher grit scores have been associated with improved medical student performance on surgery clerkships and decreased likelihood of attrition among surgery residents.[41,42] In a moving tribute to the legacy of Dr. John Cameron, Vickers et al.[18] observed that selecting gritty applicants and fostering resilience among surgical trainees could solve burnout problems and—perhaps more importantly—produce a generation of great surgeons. General surgery interns who expect to work more than 80 h per week as an attending and experience stress and malpractice litigation are less likely to attrite; it seems reasonable to elicit these expectations during the residency interview process, and select applicants who expect to face these challenges.[43,44] Another potentially useful strategy is to ask applicants to describe a significant personal failure and how they responded. In the authors' experience, failures occurring prior to medical school acceptance offer especially valuable insights regarding innate grit.

Optimism may yield a performance advantage as well. Intuitively, it would seem that success leads to happiness, but this is backwards; happiness leads to success. In the aptly named "The Happiness Advantage," Shawn Achor likens the theory that happiness revolves around success to the Copernican theory that the sun revolves around the earth. Rather, "when we are happy-when our mindset and mood are positive-we are smarter, more motivated, and thus more successful. Happiness is the center, and success revolves around it."[45] In a meta-analysis of 225 articles including more than 275,000 participants from several occupations and people groups, happiness and positive affect were not only associated with success, but often preceded success.[46] Longitudinal studies of hospital employees, automobile manufacturing workers, college students, and Catholic nuns have all concluded that happiness and positivity at young ages are associated with subsequent long-term success, manifest as better performance reviews, higher pay, and greater health and longevity.[15,16,47,48] This may occur because happy people are more creative, intellectual, social, and collaborative.[45,49,50]

Discussion

It is possible to develop grit and optimism

Proposed methods for developing grit and optimism (Table 2) have been developed and applied among several people groups, but not surgeons; it is unclear whether these methods would be effective in surgery.

Maintain optimal levels of positivity

Levels of positivity can be understood as a ratio of positivity to negativity. The weight of evidence suggests that a ratio of three to six is optimal.[51–54] Lower ratios have been associated with divorce and lower business team performance.[52,53,55] To increase a low ratio, one might reframe negative circumstances or events to find positive meaning, e.g. viewing failures as opportunities for reflection, refinement, growth, and improvement. Thought patterns engrain in the human mind, described as the 'Tetris effect'; taking a few minutes each day to recall things that have gone well increases happiness, with lasting effects.[45,56] Too much positivity may also be detrimental. Ratios exceeding 11 are also associated with lower business team performance.[53]

Pursue major challenges that match personal skills

Human performance of motor skills and dexterity tasks, like surgery, can be augmented by the flow state, characterized by a singular and holistic focus on a primary task while other tasks and distractions fade from consciousness.[57,58] Flow is associated with prolonged personal and professional satisfaction and improved performance in several domains.[57,59] Its unique physiologic signature involves deeper breaths, decreased heart rate variability, increased diastolic blood pressure, and activation of the zygomaticus major facial muscle, which occurs with happiness and arousal.[60] Together, these physiologic changes suggest sympathetic nervous system activation with parasympathetic co-activation, which may allow for more precise autonomic control and fine-tuning of end-organ function.[61] Flow is experienced when situational demands and personal skills are both high.[62] When situational demands exceed skill and ability, anxiety ensues; when skill and ability exceed situational demands, apathy ensues. This has important implications for graduated surgical trainee autonomy in and outside of the operating room, and the process of building trainee strengths and skills to meet great professional demands.

Engage in deliberate practice to improve personal skills

The flow state and optimal performance both depend on personal skill levels; therefore, methods for improving personal skills deserve further attention. Skill is most effectively built through persistent, high quality, deliberate practice.[63,64] Deliberate practice involves generating a stretch goal, maintaining full concentration and effort in practicing to achieve the goal, obtaining immediate and formative feedback, and repeating this process with reflection and refinement over time.[40] Deliberate practice yields expert performance in medicine and surgery. Longer duration of training and greater specialization have been associated with improved diagnostic acumen for rare and complex diseases, but not common diseases.[64,65] These observations may be attributable to the necessity for expert clinical reasoning and cognition in diagnosing rare and complex disease, but not common diseases.[66] High-volume surgeons tend to have better outcomes than low-volume surgeons.[67–69] Yet, even among high-volume surgeons, there is substantial variability in outcomes.[67] Deliberate practice may

Table 2
Methods for improving performance by cultivating grit and optimism.

Method	Description
Maintain optimal positivity: not too little, not too much	The optimal ratio of positive to negative statements and interactions ≈3–6; to increase the ratio, reframe negative circumstances to find positive meaning and spend a few minutes each day recalling things that have gone well
Pursue major challenges that match personal skills	Flow states of singular focus occur when situational demands and personal skills are high, are associated with personal satisfaction and peak performance
Engage in deliberate practice to improve personal skills	Generate a stretch goal, practice, obtain formative feedback, repeat and refine over time
Persist in hard work over time, valuing effort more than talent	Talent and effort produce skill; skill and effort produce achievement
Pursue higher meaning and purpose in work and life	Effort and practice are sustained by strong motivation to achieve meaningful goals and serve a greater purpose, which are associated with improved performance

account for variability in outcomes.[70] The association between greater surgical skill and improved patient outcomes supports this hypothesis.[71] Skill acquisition allows pursuit of progressively greater challenges and continual growth.

Persist in hard work over time, valuing effort more than talent

Deliberate practice requires sustained effort over time. Some degree of raw talent is necessary to become highly skilled, but consistent expert performance may depend on effort more than talent. The psychologist and author Angela Duckworth proposed this framework for achievement, in which effort counts twice:[40,72]

talent x effort = skill

skill x effort = achievement

This framework is consistent with scientific evidence regarding deliberate practice and expert performance.[63,64] Effort is a great equalizer. Intellect and talent are difficult to modulate, but relentless effort is not. Duckworth proposes that sustained effort can be used to achieve a goal and foster grit by choosing to do a difficult thing continually until the task is complete or reaches a natural stopping point, refusing to quit after a bad day or unexpected challenge.

Pursue higher meaning and purpose in work and life

Consistent effort and deliberate practice are difficult to sustain without strong motivation. As David Brooks explains, "…hard work and resilience can only happen when there is a strong desire. Grit is thus downstream from longing. People need a powerful why if they are going to be able to endure any how."[73] Meaningful goals and serving a higher purpose can be powerful motivators. Employees who see their work as a calling—rather than a job that pays bills or a career that builds social status and prestige—are more satisfied with their work and life.[74] Quinn and Thakor describe how a corporation can shift its focus from economic gains to organizational purpose, energizing employees, creating a renaissance of productivity, and subsequently tripling its stock price.[75] Among West Point cadets, internal motivations (e.g. desire to serve as an Army officer, being a soldier) are associated with greater likelihood of graduating from West Point and winning promotion during the mandatory five-year period of military service; instrumental motivations (e.g. the prospect of personal gain associated with attending West Point, getting a good job that pays well) are associated with attrition.[76] It is unclear whether pursuing higher meaning and purpose can be taught; selecting it among surgical residency applicants may be more effective.[18]

Structural and organizational support for grit and optimism in surgery

Surgical departments should consider moving beyond structural and organizational changes targeting surgeon burnout (i.e., changes to workforces, call schedules, duty hours, and compensation plans), and cultivate grit and optimism.[2,5–8] Departmental leaders have weekly opportunities to set a constructive tone for Morbidity and Mortality conferences, promoting candor and sincerity in discussing errors and adverse outcomes while focusing on opportunities for improvement. Departments should consider investing in training and career development opportunities for surgeons to improve their personal skills and meet greater challenges in caring for patients, advancing surgical research, and investing in trainee education. Finally, valuing effort (i.e., work product and clinical volume) need not conflict higher meaning and purpose in work and life, as stated by Theodore Roosevelt: "Far and away the best prize life has to offer is working hard at work worth doing." Fostering a culture that embraces these principles is one of the more difficult and important tasks surgical departments perform, requiring consistent leadership by example and inspiration for the next generation of leaders in surgery to do the same.

The Happy Warrior ethos

Following the death of Lord Nelson, legendary admiral of the British Royal Navy during the Napoleonic wars, the poet William Wordsworth composed "Character of the Happy Warrior."[77] Long before learned helplessness research and the positive psychology movement, Wordsworth describes the human capacity for grit, resilience, and post-traumatic growth:

> Who, doomed to go in company with Pain,
>
> And Fear, and Bloodshed, miserable train!
>
> Turns his necessity to glorious gain;
>
> In face of these doth exercise a power
>
> Which is our human nature's highest dower:
>
> Controls them and subdues, transmutes, bereaves
>
> Of their bad influence, and their good receives

Here, Wordsworth describes the value of internal motivations and scoffs instrumental motivations, perspectives that were validated in a study of West Point cadets more than 200 years later:[76]

> Who comprehends his trust, and to the same
>
> Keeps faithful with a singleness of aim;
>
> And therefore does not stoop, nor lie in wait

For wealth, or honours, or for worldly state

Finally, Woodsworth describes optimism and inspiration facing awful circumstances:

But who, if he be called upon to face

Some awful moment to which Heaven has joined

Great issues, good or bad for human kind,

Is happy as a Lover; and attired

With sudden brightness, like a Man inspired

Conclusions

Overcoming a challenge or failure increases the likelihood of doing so again in the future. That which does not kill us can make us stronger or weaker; grit and optimism shift this balance toward strength and yield performance advantages. Studies of non-surgeon populations suggest that it is possible to develop grit and optimism. Proposed methods include maintaining optimal levels of positivity, pursuing major challenges that match personal skills, engaging in deliberate practice to improve personal skills, persisting in hard work over time, valuing effort more than talent, and pursuing higher meaning and purpose in work and life. These methods are actionable on personal and departmental levels. Grit and optimism also depend on baseline personal characteristics and are difficult to teach; selecting gritty, optimistic surgical residency applicants may also be effective in mitigating burnout and—perhaps more importantly—producing a great generation of surgeons.

Acknowledgements

The authors have no relevant conflicts of interest.

References

1. Shanafelt TD, Balch CM, Bechamps GJ, et al. Burnout and career satisfaction among American surgeons. *Ann Surg*. 2009 Sep;250(3):463–471.
2. Pulcrano M, Evans SR, Sosin M. Quality of life and burnout rates across surgical specialties: a systematic review. *JAMA Surg*. 2016 Oct 1;151(10):970–978.
3. West CP, Huschka MM, Novotny PJ, et al. Association of perceived medical errors with resident distress and empathy: a prospective longitudinal study. *J Am Med Assoc*. 2006 Sep 6;296(9):1071–1078.
4. FirthCozens J, Greenhalgh J. Doctors' perceptions of the links between stress and lowered clinical care. *Soc Sci Med*. 1997 Apr;44(7):1017–1022.
5. West CP, Dyrbye LN, Erwin PJ, Shanafelt TD. Interventions to prevent and reduce physician burnout: a systematic review and meta-analysis. *Lancet*. 2016 Nov 5;388(10057):2272–2281.
6. Hutter MM, Kellogg KC, Ferguson CM, et al. The impact of the 80-hour resident workweek on surgical residents and attending surgeons. *Ann Surg*. 2006 Jun;243(6):864–875.
7. Campbell DA, Sonnad SS, Eckhauser FE, et al. Burnout among American surgeons. *Surgery*. 2001 Oct;130(4):696–702.
8. Williford ML, Scarlet S, Meyers MO, et al. Multiple-institution comparison of resident and faculty perceptions of burnout and depression during surgical training. *JAMA Surg*. 2018 Aug;153(8):705–711.
9. Ofri D. The business of health care depends on exploiting doctors and nurses. New York times. Accessed September 2, 2019. Available at: https://www.nytimes.com/2019/06/08/opinion/sunday/hospitals-doctors-nurses-burnout.html; 2019. June 8.
10. Sawin RS. Optimizing joy in surgery. *JAMA Surg*. 2019 Jul 31;154(10):893–894. https://doi.org/10.1001/jamasurg.2019.1522.
11. Thirlby RC. The top 10 reasons why general surgery is a great career. *Arch Surg Chicago*. 2007 May;142(5):423–429.
12. Peterson C, Park N, Pole N, et al. Strengths of character and posttraumatic growth. *J Trauma Stress*. 2008 Apr;21(2):214–217.
13. Seligman ME. Building resilience. *Harv Bus Rev*. 2011 Apr;89(4):100–106, 38.
14. Seligman ME, Steen TA, Park N, Peterson C. Positive psychology progress: empirical validation of interventions. *Am Psychol*. 2005 Jul-Aug;60(5):410–421.
15. Danner DD, Snowdon DA, Friesen WV. Positive emotions in early life and longevity: findings from the nun study. *J Pers Soc Psychol*. 2001 May;80(5):804–813.
16. Cohen S, Doyle WJ, Turner RB, et al. Emotional style and susceptibility to the common cold. *Psychosom Med*. 2003 Jul-Aug;65(4):652–657.
17. Maier SF, Seligman ME. Learned helplessness at fifty: insights from neuroscience. *Psychol Rev*. 2016 Jul;123(4):349–367.
18. Vickers SM, Vickers AL. GRIT and resilience: keys to the development of the halsted resident in the John Cameron era. *Ann Surg*. 2018 Feb;267(2S Suppl 2):S22–S25.
19. Lebares CC, Guvva EV, Ascher NL, et al. Burnout and stress among US surgery residents: psychological distress and resilience. *J Am Coll Surg*. 2018 Jan;226(1):80–90.
20. Seligman ME, Maier SF. Failure to escape traumatic shock. *J Exp Psychol*. 1967 May;74(1):1–9.
21. Hiroto DS, Seligman ME. Generality of learned helplessness in man. *J Pers Soc Psychol*. 1975;31(2):311–327.
22. Nietzsche FW, Large D. *Twilight of the Idols, or, How to Philosophize with a Hammer. Oxford World's Classics Pbk*. Oxford ;: Oxford University Press; 2008:124. xlii.
23. Nietzsche FW, Large D. *Ecce homo : How to Become what You Are*. Oxford ; New York: Oxford University Press; 2007:138. xxxvii.
24. Iremonger L. *The Fiery Chariot: A Study of British Prime Ministers and the Search for Love*. London: Secker & Warburg; 1970:344. xvi.
25. Silverman SM. Parental loss and scientists. *Sci Stud*. 1974;4(3):259–264.
26. Martindale C. Father's absence, psychopathology, and poetic eminence. *Psychol Rep*. 1972 Dec;31(3):843–847.
27. Gladwell M. *David and Goliath : Underdogs, Misfits, and the Art of Battling Giants*. first ed. ix. New York: Little, Brown and Company; 2013:305.
28. MacCurdy JT. *The Structure of Morale*. Cambridge Eng.: The University press; 1943. vi p., 1 l., 223, 1 p. p.
29. Wang Y, Jones B, Wang D. *Early-career Setback and Future Career Impact*; 2019. arXiv:1903.06958. Submitted 16 Mar . Accessed August 4, 2019.
30. Tversky A, Kahneman D. Advances in prospect-theory - cumulative representation of uncertainty. *J Risk Uncertain*. 1992 Oct;5(4):297–323.
31. Gustafsson H, Sagar SS, Stenling A. Fear of failure, psychological stress, and burnout among adolescent athletes competing in high level sport. *Scand J Med Sci Sports*. 2017 Dec;27(12):2091–2102.
32. Murr D, Feichtinger P, Larkin P, et al. Psychological talent predictors in youth soccer: a systematic review of the prognostic relevance of psychomotor, perceptual-cognitive and personality-related factors. *PloS One*. 2018;13(10), e0205337.
33. Burnstein E. Fear of failure, achievement motivation, and aspiring to prestigeful occupations. *J Abnorm Soc Psychol*. 1963 Aug;67:189–193.
34. McClelland DC. *The Achieving Society*. Princeton, N.J.: Van Nostrand; 1961:512.
35. Gillham JE, Reivich KJ, Freres DR, et al. School-based prevention of depressive symptoms: a randomized controlled study of the effectiveness and specificity of the Penn Resiliency Program. *J Consult Clin Psychol*. 2007 Feb;75(1):9–19.
36. Reivich KJ, Seligman ME, McBride S. Master resilience training in the U.S. Army. *Am Psychol*. 2011 Jan;66(1):25–34.
37. Griffith J, West C. Master resilience training and its relationship to individual well-being and stress buffering among army national guard soldiers. *J Behav Health Serv Res*. 2013 Apr;40(2):140–155.
38. Farina EK, Thompson LA, Knapik JJ, et al. Physical performance, demographic, psychological, and physiological predictors of success in the U.S. Army Special Forces Assessment and Selection course. *Physiol Behav*. 2019 Aug 8:112647.
39. Hill BD, Aita SL. The positive side of effort: a review of the impact of motivation and engagement on neuropsychological performance. *Appl Neuropsychol Adult*. 2018 Jul-Aug;25(4):312–317.
40. Duckworth A. *Grit : The Power of Passion and Perseverance*. First Scribner hardcover edition. New York: Scribner; 2016:333. xv.
41. Cortez AR, Winer LK, Kim Y, et al. Predictors of medical student success on the surgery clerkship. *Am J Surg*. 2019 Jan;217(1):169–174.
42. Salles A, Lin D, Liebert C, et al. Grit as a predictor of risk of attrition in surgical residency. *Am J Surg*. 2017 Feb;213(2):288–291.
43. Abelson JS, Sosa JA, Symer MM, et al. Association of expectations of training with attrition in general surgery residents. *JAMA Surg*. 2018 Aug 1;153(8):712–717.
44. Shaw C, Sarosi Jr GA. Reducing surgical resident attrition. *JAMA Surg*. 2018 Aug 1;153(8):717–718.
45. Achor S. *The Happiness Advantage : The Seven Principles of Positive Psychology that Fuel Success and Performance at Work*. first ed. ix. New York: Broadway Books; 2010:236.
46. Lyubomirsky S, King L, Diener E. The benefits of frequent positive affect: does happiness lead to success? *Psychol Bull*. 2005 Nov;131(6):803–855.
47. Staw BM, Sutton RI, Pelled LH. Employee positive emotion and favorable outcomes at the workplace. *Organ Sci*. 1994 Feb;5(1):51–71.
48. Diener E, Nickerson C, Lucas RE, Sandvik E. Dispositional affect and job outcomes. *Soc Indicat Res*. 2002 Sep;59(3):229–259.
49. Fredrickson BL. The role of positive emotions in positive psychology. The broaden-and-build theory of positive emotions. *Am Psychol*. 2001 Mar;56(3):218–226.
50. Fredrickson BL, Branigan C. Positive emotions broaden the scope of attention and thought-action repertoires. *Cognit Emot*. 2005 May 1;19(3):313–332.
51. Brown NJ, Sokal AD, Friedman HL. The complex dynamics of wishful thinking:

the critical positivity ratio. *Am Psychol*. 2013 Dec;68(9):801–813.
52. Gottman JM. What predicts divorce?. In: *The Relationship between Marital Processes and Marital Outcomes*. Hillsdale, N.J.: Lawrence Erlbaum Associates; 1994:521. xvi.
53. Losada M, Heaphy E. The role of positivity and connectivity in the performance of business teams - a nonlinear dynamics model. *Am Behav Sci*. 2004 Feb;47(6):740–765.
54. Fredrickson BL, Losada MF. Positive affect and the complex dynamics of human flourishing. *Am Psychol*. 2005 Oct;60(7):678–686.
55. Buehlman K, Gottman J, Katz L. How a couple views their past predicts their future: predicting divorce from an oral history interview. *J Fam Psychol*. 1992;5(3-4):295–318.
56. Stickgold R, Malia A, Maguire D, et al. Replaying the game: hypnagogic images in normals and amnesics. *Science*. 2000 Oct 13;290(5490):350–353.
57. Csikszentmihalyi M. *Flow : The Psychology of Optimal Experience*. first ed. New York: Harper & Row; 1990:303. xii.
58. Jackson SA. Toward a conceptual understanding of the flow experience in elite athletes. *Res Q Exerc Sport*. 1996 Mar;67(1):76–90.
59. Csikszentmihalyi M, Csikszentmihalyi IS. *Optimal Experience : Psychological Studies of Flow in Consciousness*. Cambridge ; New York: Cambridge University Press; 1988:416. xiv.
60. de Manzano O, Theorell T, Harmat L, Ullen F. The psychophysiology of flow during piano playing. *Emotion*. 2010 Jun;10(3):301–311.
61. Berntson GG, Cacioppo JT, Quigley KS. Autonomic determinism: the modes of autonomic control, the doctrine of autonomic space, and the laws of autonomic constraint. *Psychol Rev*. 1991 Oct;98(4):459–487.
62. Jackson SA, Csikszentmihalyi M. *Flow in Sports*. viii. Champaign, IL: Human Kinetics; 1999:183.
63. Ericsson KA. Deliberate practice and acquisition of expert performance: a general overview. *Acad Emerg Med*. 2008 Nov;15(11):988–994.
64. Ericsson KA. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. *Acad Med*. 2004 Oct;79(10 Suppl):S70–S81.
65. Rikers RMJP, Schmidt HG, Boshuizen HPA. On the constraints of encapsulated knowledge: clinical case representations by medical experts and subexperts. *Cognit InStruct*. 2002;20(1):27–45.
66. Elstein AS, Schwartz A. Clinical problem solving and diagnostic decision making: selective review of the cognitive literature. *BMJ*. 2002 Mar 23;324(7339):729–732.
67. Begg CB, Riedel ER, Bach PB, et al. Variations in morbidity after radical prostatectomy. *N Engl J Med*. 2002 Apr 11;346(15):1138–1144.
68. Schrag D, Panageas KS, Riedel E, et al. Hospital and surgeon procedure volume as predictors of outcome following rectal cancer resection. *Ann Surg*. 2002 Nov;236(5):583–592.
69. Cowan Jr JA, Dimick JB, Thompson BG, et al. Surgeon volume as an indicator of outcomes after carotid endarterectomy: an effect independent of specialty practice and hospital volume. *J Am Coll Surg*. 2002 Dec;195(6):814–821.
70. Hashimoto DA, Sirimanna P, Gomez ED, et al. Deliberate practice enhances quality of laparoscopic surgical performance in a randomized controlled trial: from arrested development to expert performance. *Surg Endosc*. 2015 Nov;29(11):3154–3162.
71. Birkmeyer JD, Finks JF, O'Reilly A, et al. Surgical skill and complication rates after bariatric surgery. *N Engl J Med*. 2013 Oct 10;369(15):1434–1442.
72. Duckworth AL, Seligman ME. Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychol Sci*. 2005 Dec;16(12):939–944.
73. Brooks D. Putting grit in its place. New York times. A23. Available at: https://www.nytimes.com/2016/05/10/opinion/putting-grit-in-its-place.html; May 10, 2016. Accessed August 12, 2019.
74. Wrzesniewski A, McCauley C, Rozin P, Schwartz B. Jobs, careers, and callings: people's relations to their work. *J Res Pers*. 1997 Mar;31(1):21–33.
75. Quinn RE, Thakor AV. Creating a purpose-driven organization. *Harv Bus Rev*. 2018 Jul-Aug;96(4):78–85.
76. Wrzesniewski A, Schwartz B, Cong X, et al. Multiple types of motives don't multiply the motivation of West Point cadets. *Proc Natl Acad Sci USA*. 2014 Jul 29;111(30):10990–10995.
77. Wordsworth W. *Character of the Happy Warrior : A Poem*. New York: Hobby Press; 1913:5.